Appendix F

Part VII-Test Method to Determine the Burnthrough Resistance of Thermal/Acoustical Insulation Materials

The following test method is used to evaluate the burnthrough resistance characteristics of aircraft thermal-acoustic insulation materials when exposed to a high intensity open flame.

(a) Definitions.

(1) Burnthrough Time. The burnthrough time is measured at the inboard side of each of the insulation blanket specimens. The burnthrough time is defined as the time required, in seconds, for the burner flame to penetrate the test specimen, and/or the time required for the heat flux to reach 2.0 Btu/ft^{2}sec on the inboard side, at a distance of 12 inches from the front surface of the insulation blanket test frame, whichever is sooner.

(2) Specimen Set. A specimen set consists of two insulation blanket specimens. Both specimens must represent the same production insulation blanket construction and materials, proportioned to correspond to the specimen size.

(3) Insulation Blanket Specimen. The insulation blanket specimen is one of two specimens positioned in either side of the test rig, at an angle of 30 degrees with respect to vertical.

(b) Apparatus.

(1) The arrangement of the test apparatus is shown in figures 1 and 2 and shall include the components described in this section. The burner stand shall have the capability of swinging

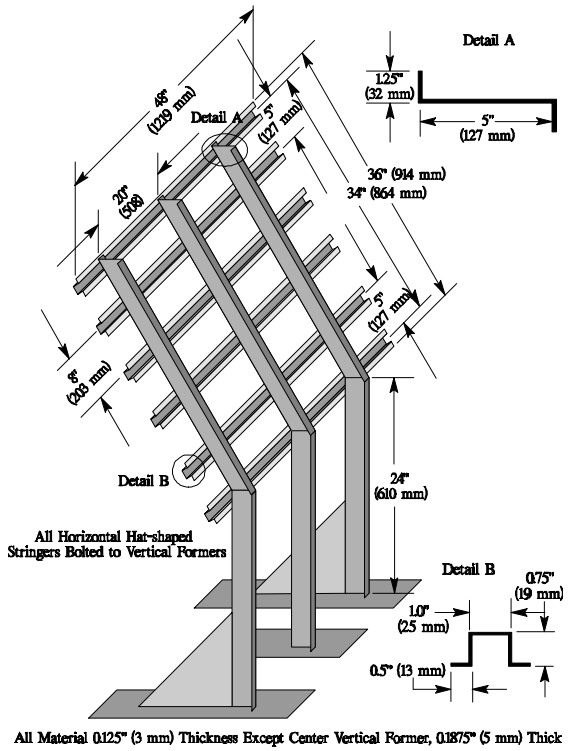

Figure 1. Burnthrough Test Apparatus Specimen Holder

the burner away from the test specimen during warm-up.

(2) Test Burner. The test burner shall be a modified gun-type such as the Park Model DPL 3400. Flame characteristics may be enhanced with the optional use of a static disc turbulator or a temperature compensation fuel nozzle.

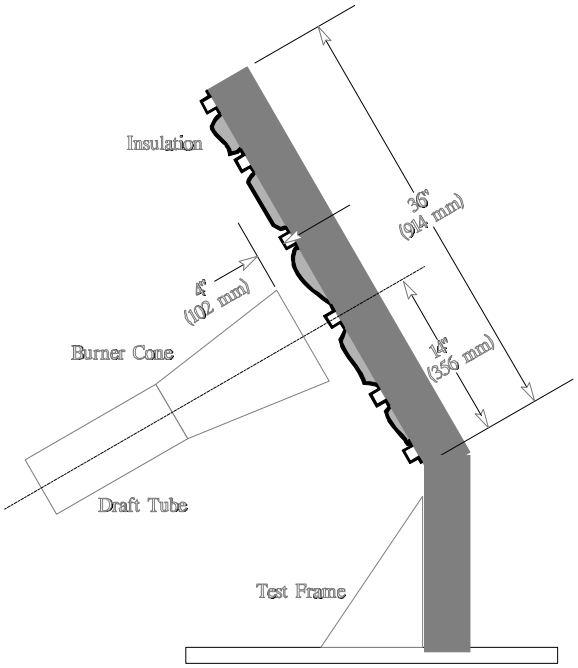

Figure 2. Burnthrough Test Apparatus

(i) Nozzle. A nozzle is required to maintain the fuel pressure to yield a nominal 6.0 gal/hr (0.378 L/min) fuel flow. A Monarch manufactured 80 degree PL (hollow cone) nozzle nominally rated at 6.0 gal/hr at 100 lb/in^2 (0.71 MPa) has been found to deliver a proper spray pattern. Minor deviations to the fuel nozzle spray angle, fuel pressure, or other similar parameters are acceptable if the nominal fuel flow rate and temperature and heat flux measurements conform to the requirements of paragraph (e) of this part of the appendix.

(ii) Burner Cone. A 12 $\pm$ 0.125-inch (305 $\pm$ 6 mm) burner extension cone shall be installed at the end of the draft tube. The cone shall have an opening 6 $\pm$ 0.125-inch (152 $\pm$ 6 mm) high and 11 $\pm$ 0.125-inch (280 $\pm$ 6 mm) wide (figure 3).

(iii) Fuel. JP-8, Jet A, or their international equivalent has been found to satisfactorily deliver a 6.0 $\pm$ 0.2 gal/hr flow rate. If this fuel is unavailable, ASTM K2 fuel (Number 2 grade kerosene) or ASTM D2 fuel (Number 2 grade fuel oil or Number 2 diesel fuel) are acceptable if the nominal fuel flow rate, temperature and heat flux measurements conform to the requirements of paragraph (e) of this part of the appendix.

(iv) Fuel Pressure Regulator. A fuel pressure regulator, adjusted to deliver 6.0 gal/hr (0.378 L/min) nominal, shall be provided. An operating fuel pressure of 100 lb/in^2 for a 6.0 gal/hr 80 degree spray angle nozzle (such as a PL type) has been found to be satisfactory to deliver 6.0 $\pm$ 0.2 gal/hr (0.378 L/min).

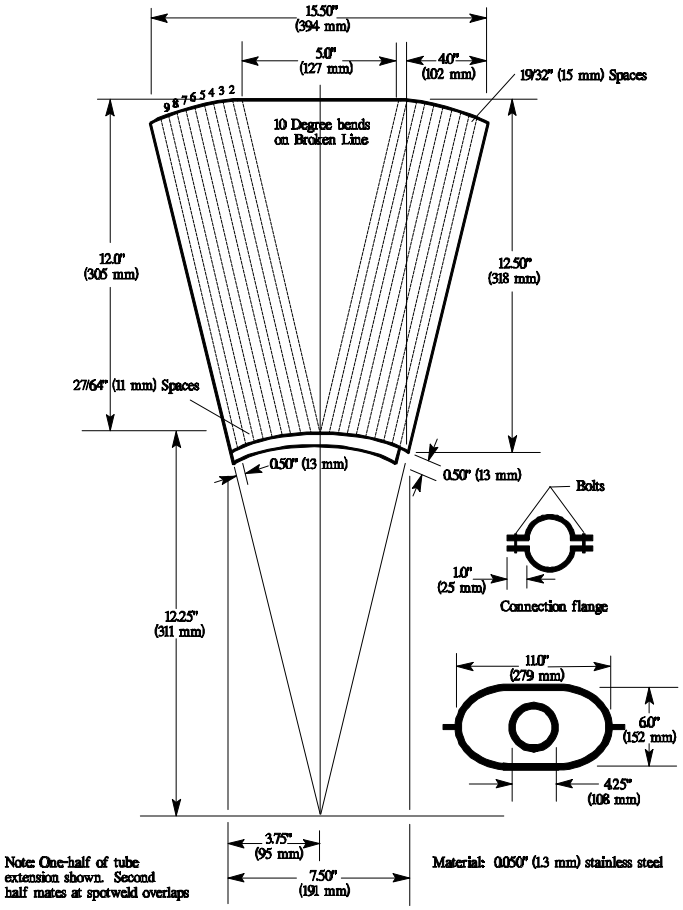

Figure 3. Burner Draft Tube Extension Cone Diagram

(3) Calibration Rig & Equipment. A calibration rig shall be constructed to incorporate a calorimeter and thermocouple rake for the measurement of both heat flux and temperature. A combined temperature and heat flux calibration rig enables a quick transition between these devices, so that the influence of air intake velocity on heat flux and temperature can be analyzed without necessitating removal of the calibration rig. Individual calibration rigs are also acceptable.

(i) Calorimeter. The calorimeter shall be a total heat flux, foil type Gardon Gage of an appropriate range such as 0-20 Btu/ft^2-sec (0-22.7 W/cm^2), accurate to $\pm$ 3% of the indicated reading. The heat flux calibration method shall be in accordance with Appendix F, Part VI, paragraph (b)(7).

(A) Calorimeter Mounting. The calorimeter shall be mounted in a 6- by 12- $\pm$ 0.125 inch (152- by 305- $\pm$ 3 mm) by 0.75 $\pm$ 0.125 inch (19 mm $\pm$ 3 mm) thick insulating block which is attached to a calibration rig for attachment to the test rig during calibration (figure 4). The insulating block shall be monitored for deterioration and replaced when necessary. The mounting shall be adjusted as necessary to ensure that the calorimeter face is parallel to the exit plane of the test burner cone.

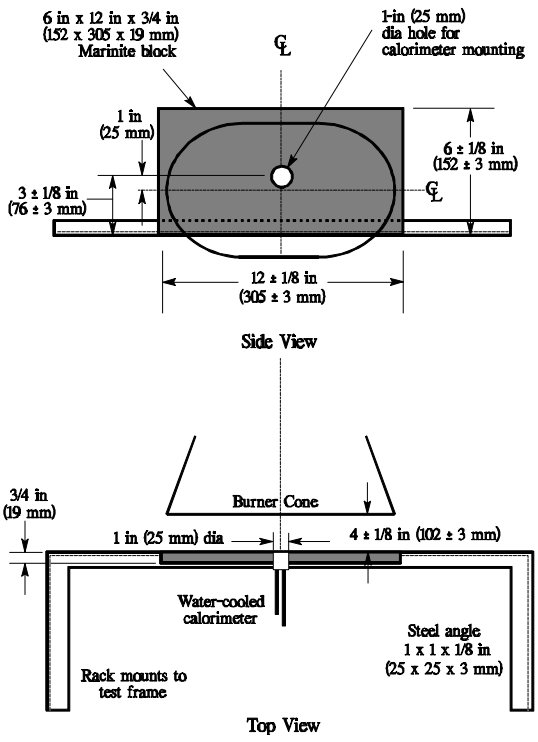

Figure 4. Calorimeter Position Respective of Burner Cone

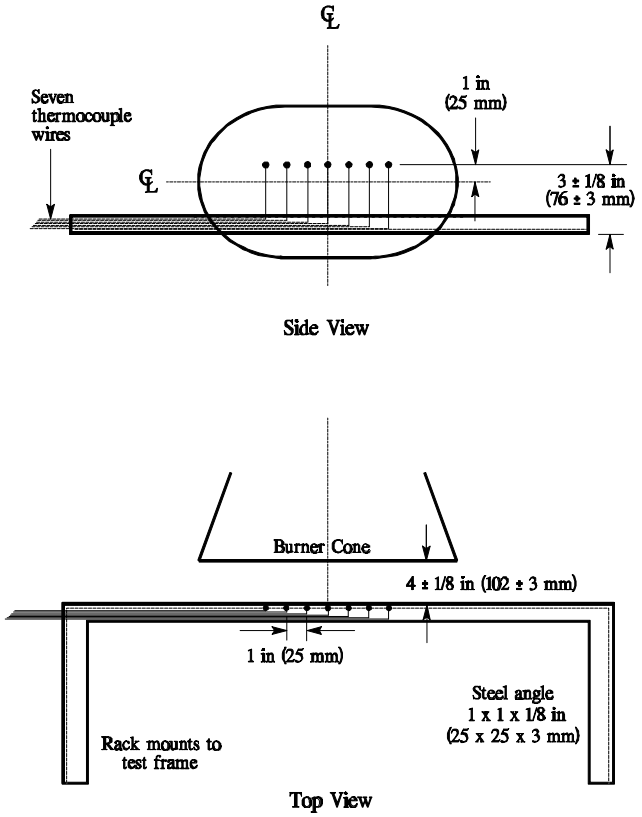

Figure 5. Thermocouple Rake Position Respective of Burner Cone

(ii) Thermocouples. Seven 1/8-inch ceramic packed, metal sheathed, type K (Chromel-alumel), grounded junction thermocouples with a nominal 24 American Wire Gauge (AWG) size conductor shall be provided for calibration. The thermocouples shall be attached to a steel angle bracket to form a thermocouple rake for placement in the calibration rig during burner calibration (figure 5).

(iii) Air Velocity Meter. A vane-type air velocity meter must be used to calibrate the velocity of air entering the burner. An Omega Engineering Model HH30A has been shown to be satisfactory. A suitable adapter used to attach the measuring device to the inlet side of the burner is required to prevent air from entering the burner other than through the device, which would produce erroneously low readings.

(4) Test Specimen Mounting Frame. The mounting frame for the test specimens shall be fabricated of 1/8-inch thick steel as shown in figure 1, except for the center vertical former, which should be ¼-inch thick to minimize warpage. The specimen mounting frame stringers (horizontal) should be bolted to the test frame formers (vertical) such that the expansion of the stringers will not cause the entire structure to warp. The mounting frame shall be used for mounting the 2 insulation blanket test specimens as shown in figure 2.

(5) Backface Calorimeters. Two total heat flux Gardon type calorimeters shall be mounted above the insulation test specimens on the back side (cold) area of the test specimen mounting frame as shown in figure 6. The calorimeters must be positioned along the same plane as the burner cone centerline, at a distance of 4 inches from the centerline of the test frame. The heat flux calibration shall be in accordance with Appendix F, Part VI, paragraph (b)(7).

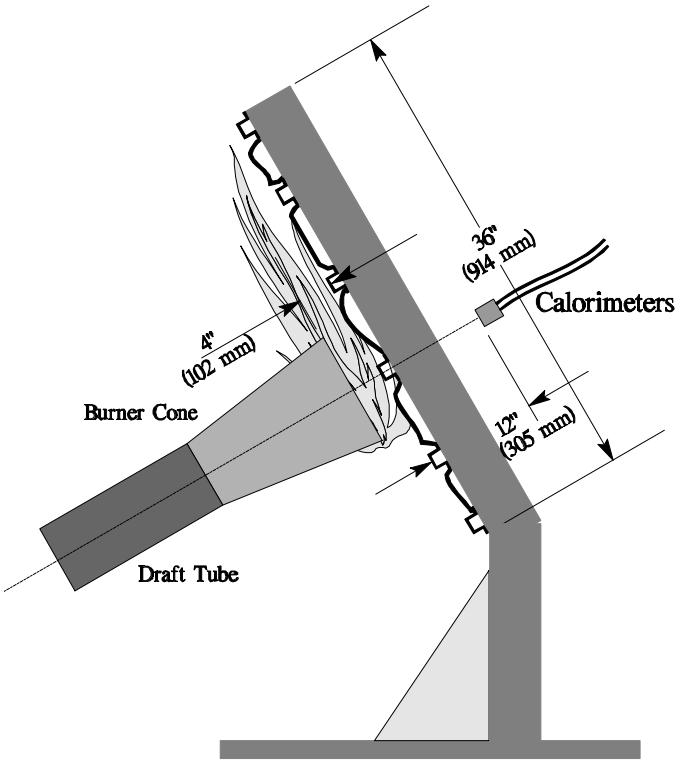

Figure 6. Position of Backface Calorimeters Respective of Test Specimen Frame

(6) Instrumentation. A recording potentiometer or other suitable calibrated instrument with an appropriate range shall be provided to measure and record the outputs of the calorimeter and the thermocouples.

(7) Timing Device. A stopwatch or other device, accurate to $\pm$ 1%, shall be provided to measure the time of application of the burner flame and burnthrough time.

(8) Test Chamber. Tests should be performed in a suitable chamber to reduce or eliminate the possibility of test fluctuation due to air movement. The chamber must have a minimum floor area of 10 by 10 feet.

(i) Ventilation Hood. The test chamber must be provided with an exhausting system capable of removing the products of combustion expelled during tests.

(c) Test Specimens.

(1) Specimen Preparation. A minimum of three specimen sets of the same construction and configuration shall be prepared for testing.

(2) The Insulation Blanket Test Specimen. For batt-type materials such as fiberglass, the constructed, finished blanket specimen assemblies shall be 32 inches wide by 36 inches length, exclusive of heat sealed film edges.

For rigid and other non-conforming types of insulation materials, the finished test specimens shall fit into the test rig in such a manner as to replicate the actual in-service installation.

(3) Construction. Each of the specimens tested shall be fabricated using the principal components (i.e., insulation, fire barrier material if used, and moisture barrier film) and assembly processes (representative seams and closures).

(i) Fire Barrier Material. If the insulation blanket is constructed with a fire barrier material, the fire barrier material shall be placed in a manner reflective of the installed arrangement (e.g., if the material will be placed on the outboard side of the insulation material, inside the moisture film, it must be placed accordingly in the test specimen).

(ii) Insulation Material. Blankets that utilize more than one variety of insulation (composition, density, etc.) shall have specimen sets constructed that reflect the insulation combination used. If, however, several blanket types use similar insulation combinations, it is not necessary to test each combination if it is possible to bracket the various combinations.

(iii) Moisture Barrier Film. If a production blanket construction utilizes more than one type of moisture barrier film, separate tests must be performed on each combination. For example, if a polyimide film is used in conjunction with an insulation in order to enhance the burnthrough capabilities, the same insulation with a polyvinyl fluoride must also be tested.

(4) Installation on Test Frame. The blanket test specimens must be attached to the test frame using 12 steel spring type clamps as shown in figure 7. The clamps must be used to hold the blankets in place in both of the outer vertical formers, as well as the center vertical former (4 clamps per former). Place the top and bottom clamps 6 inches from the top and bottom of the test frame, respectively. Place the middle clamps 8 inches from the top and bottom clamps.

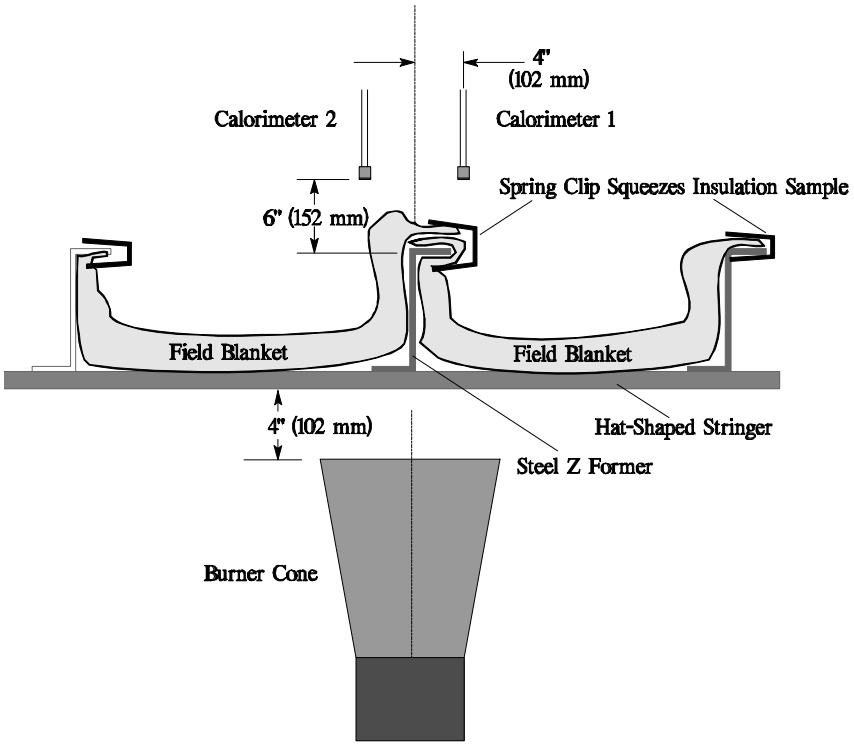

Figure 7. Test Specimen Installation on Test Frame

(i) Alternative Installation Method. For blanket materials that cannot be installed in accordance with paragraph (4) above, the blankets may be installed in the frame using the actual, in-service attachment methods.

(ii) Installation Details (TBD)

(5) Conditioning. The specimens shall be conditioned at $70^{o} \pm 5^{o}F$ ($21^{o} \pm 2^{o}C$) and 55% $\pm$ 10% relative humidity for a minimum of 24 hr prior to testing.

(d) Preparation of Apparatus

(1) Level and center the frame assembly to ensure alignment of the calorimeter and/or thermocouple rake with the burner cone.

(2) Turn on the ventilation hood for the test chamber. Do not turn on the burner blower. Measure the airflow of the test chamber using a vane anemometer or equivalent measuring device. The vertical air velocity just behind the top of the upper insulation blanket test specimen shall be 100 $\pm$ 50 ft/min. The horizontal air velocity at this point shall be less than 50 ft/min.

(3) If a calibrated flow meter is not available, measure the fuel flow rate using a graduated cylinder of appropriate size. Turn on the burner motor/fuel pump, after insuring that the igniter system is turned off. Collect the fuel via a plastic or rubber tube into the graduated cylinder for a 2 minute period. Determine the flow rate in gallons per hour. The fuel flow rate shall be 6.0 $\pm$ 0.2 gallons per hour.

(e) Calibration

(1) Secure the calibration rig to the test specimen frame. Position the burner so that it is centered in front of the calibration rig and the vertical plane of the burner cone exit is at a distance of 4 ± 0.125 inches (102 ± 3 mm) from the calorimeter face. Ensure that the horizontal centerline of the burner cone is offset 1 inch below the horizontal centerline of the calorimeter (figure 8). Without disturbing the burner position, slide the thermocouple rake portion of the calibration rig in front of the burner, such that the middle thermocouple (number 4 of 7) is centered on the burner cone.

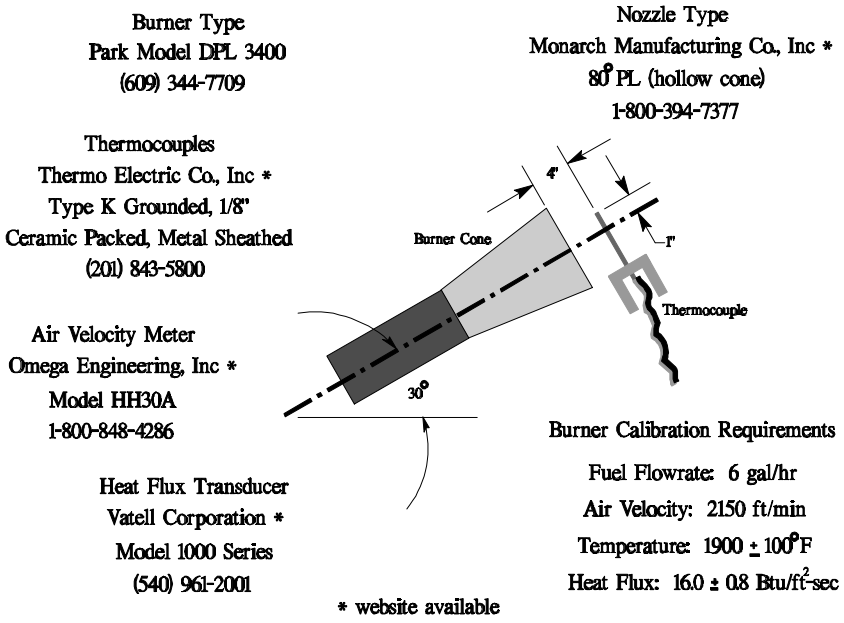

Figure 8. Burner Information and Calibration Settings

Ensure that the horizontal centerline of the burner cone is also offset 1 inch below the horizontal centerline of the thermocouple tips[1]. If individual calibration rigs are used, swing the burner to each position to ensure proper alignment between the cone and the calorimeter and thermocouple rake.

(2) Position the air velocity meter in the adapter, making certain that no gaps exist where air could leak around the air velocity measuring device. Turn on the blower/motor while ensuring that the fuel solenoid and igniters are off. Adjust the air intake velocity to a level of 2150 ft/min, then turn off blower/motor.

(3) Rotate the burner from the test position to the warm-up position. Prior to lighting the burner, ensure that the calorimeter face is clean of soot deposits, and there is water running through the calorimeter. Examine and clean the burner cone of any evidence of buildup of products of combustion, soot, etc. Soot buildup inside the burner cone may affect the flame characteristics

[1] The calibration rig must incorporate "detents" that ensure proper centering of both the calorimeter and the thermocouple rake with respect to the burner cone, so that rapid positioning of these devices can be achieved during the calibration procedure.

and cause calibration difficulties. Since the burner cone may distort with time, dimensions should be checked periodically.

(4) While the burner is still rotated out of the test position, turn on the blower/motor, igniters and fuel flow, and light the burner. Allow it to warm up for a period of 2 minutes. Move the burner into the test position and allow 1 minute for calorimeter stabilization, then record the heat flux once every second for a period of 30 seconds. Turn off burner, rotate out of position, and allow to cool. Calculate the average heat flux over this 30-second duration. The average heat flux should be 16.0 +/- 0.8 Btu/ft^2 sec.

(5) Position the thermocouple rake in front of the burner. After checking for proper alignment, rotate the burner to the warm-up position, turn on the blower/motor, igniters and fuel flow, and light the burner. Allow it to warm up for a period of 2 minutes. Move the burner into the test position and allow 1 minute for thermocouple stabilization, then record the temperature of each of the 7 thermocouples once every second for a period of 30 seconds. Turn off burner, rotate out of position, and allow to cool. Calculate the average temperature of each thermocouple over this 30-second period and record. The average temperature of each of the 7 thermocouples should be 1900^{o}F $\pm$ 100^{o}F.

(6) If either the heat flux or the temperatures are not within the specified range, adjust the burner intake air velocity and repeat Sections (4) and (5) above to obtain the proper values. Ensure that the inlet air velocity is within the range of 2150 ft/min $\pm$ 50 ft/min.

(7) Calibrate prior to each test until consistency has been demonstrated. After consistency has been confirmed, several tests may be conducted with calibration conducted before and after a series of tests.

(f) Test Procedure

(1) Secure the 2 insulation blanket test specimens to the test frame. The insulation blankets should be attached to the test rig center vertical former using 4 spring clamps positioned as shown in figure 7 (according to the criteria of (c)(4) or (c)(4)(i) of this part of this appendix).

(2) Ensure that the vertical plane of the burner cone is at a distance of 4 $\pm$ 0.125 inch from the outer surface of the horizontal stringers of the test specimen frame, and that the burner and test frame are both situated at a 30^o angle with respect to vertical.

(3) When ready to begin the test, direct the burner away from the test position to the warm-up position so that the flame will not impinge on the specimens. Turn on and light the burner and allow it to stabilize for 2 minutes.

(4) To begin the test, rotate the burner into the test position and simultaneously start the timing device.

(5) Expose the test specimens to the burner flame for 4 minutes and then turn off the burner. Immediately rotate the burner out of the test position.

(6) Determine (where applicable) the burnthrough time, or the point at which the heat flux exceeds 2.0 Btu/ft^2-sec.

(g) Report

(1) Identify and describe the specimen being tested.
(2) Report the number of insulation blanket specimens tested.
(3) Report the burnthrough time (if any), and the maximum heat flux/temperature on the back face of the insulation blanket test specimen, and the time at which the maximum occurred.

(h) Requirements

(1) Neither of the 2 insulation blanket test specimens shall allow fire/flame penetration in less than 240 seconds
(2) Neither of the 2 insulation blanket test specimens shall allow more than 2.0 Btu/ft^2-sec on the cold side of the insulation specimens at a point 12 inches from the face of the test rig.